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ABSTRACT

This study, by means of an experimental design, examines whether the use of an electronic manual is more effective and efficient than a print manual for the training of novice users with a music score editor program. Differences in access to the two types of manuals were looked for, and information on users' perceptions regarding the materials they used was solicited. A minimalist print manual, a hypermedia manual and two questionnaires were developed. The most prominent difference between the two manuals was the use of digital video to present procedural information in the electronic version. The rest of the information remained the same for the two manuals, as did the training strategy based on guided exploration. The research findings show an effect of the hypermedia manual in learning outcomes, access to manuals and users' perceptions. This effect might have been due to the confluence of several factors differentiating the manuals: the procedural information in the video format and the design of the interface--with limited control elements, fast access to information, and a low complementary interaction between presentation modalities--minimized the potential cognitive overload and allowed the user to start working rapidly. (Contains 26 references.) (AEF)

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On Paper or Hypermedia? the Effect of Procedural Information in Digital Video Format in the Learning of a Music Score Editor Program by Novice Users

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Abstract

In this study, and by means of an experimental contrast design, we have tried to determine whether the use of an electronic manual is more effective and efficient than a print manual for the training of novice users with a score editor program. We also looked for differences in access to the two types and for information on users' perceptions regarding the materials they used. Were developed a minimalist print manual, an hypermedia manual and two questionnaires. The most prominent difference between the two manuals was the use of digital video to present procedural information in the electronic version. The rest of the information remained the same for the two manuals, as did the training strategy based on guided exploration. The research findings show an effect of the hypermedia manual in learning outcomes, access to manuals and users' perceptions. This effect might have been due to the confluence of several factors differentiating the manuals: the procedural information in the video format and the design of the interface - with limited control elements, fast access to information and a low complementary interaction between presentation modalities- minimized the potential cognitive overload and allowed the user to start working rapidly.

Keywords: novice user training, training materials, hypermedia, minimalism, music technology.

1. Introduction

Research related to technical documentation, understood as an instructional resource, investigates design and elaboration strategies that are especially important because of their impact on learning. Educational research is deficient on empirical studies comparing novice users' learning outcomes in working with different types of documentation. This deficiency extends to a lack of contrasting on presentation modalities. It is widely expected that computers will increasingly play an important role as normal working tools in different knowledge domains, musical disciplines included (Tejada, 1998). At least in academic environments, a considerable amount of time will certainly be devoted to learning computer programs and controlling machines. Educators will need to expand their knowledge of methodologies and materials to include this type of learning.

2. Literature and hypothesis

2.1 Minimalist training materials

Carroll et al. (1987) observed the novice users' behavior and they found problems on the program documentation: it was extensive and exhaustive and did not have either a task-based approach or a system for

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error detection and correction. In their empirical studies, the model was a learner focused to act, interested principally in doing real tasks, trying to make sense of all, he/she sees, hears, reads and does; someone that uses their own hypothesis even when the evidence contradicts them; a learner with a tendency to access technical documentation in a non-linear way (Carroll, 1990). Conventional manuals do not address this novice user's needs. This explains why only a small percentage of users read technical documentation (Lazonder & van der Meij, 1993). Novice users, focused on their goals, generally explore program functions by means of a trial-and-error strategy, which technical writers try to avoid in the manuals. Furthermore, while users explore, they make many errors, which explain the high amount of time devoted to correct them -about 25% to 50% of training time (Lazonder & van der Meij, 1994, 1995). The minimalism, a model of training heavily user centered, takes on two key principles from cognitive psychology: active learning and constructivism. Users can learn more and better if they are actively involved; when they are doing something. Users do not learn so much if they follow instructions like a script. Secondly, the user builds up their own mental models combining their past experiences with new information; hence, their mental models, already constructed, are modified. It makes explicit the user's goals and involves them in real tasks. It reduces the need for extended training materials and supports error recognition and correction. Its aims are to maintain motivation, promote active learning and make the learning environment user-friendly, that is, it enables exploration that users can do without feeling frustrated by their errors. Several authors define principles for the minimalist model (Carroll 1990, 1998; Van der Meij & Carroll, 1995).[1] These share some characteristics with cognitive psychology: focus on real tasks; active learning; documentation structure based on users' real needs; brevity of materials; error recognition and correction; modularity; screen-documentation coordination system; iterative documentation design. Empirical research contrasting minimal materials and conventional ones has shown the superiority of the minimalist approach in developing training materials.[1]

2.2 Problems of non-linear information access

Interacting with information in a hypermedia structure is a complex cognitive activity. Total freedom in the choice of the pathway into a hypermedia system may mean that the user's orientation abilities decrease (Dede, 1992) and a cognitive overload can arise. The term cognitive overload refers to the additional cognitive effort and concentration needed to simultaneously perform certain tasks. This demand for additional effort is due not only to the user taking decisions about what path to follow, but also to being forced to remember his/her situation in the net and the nodes that he/she has visited. Sciarone and Meijer (1993) have shown that the freedom provided in navigating through a hypertext system provoked users' inability to do the tasks required of them and that they preferred finding the responses through the system's help rather than learning the system itself. Several authors have tried to overcome this problem by providing navigational help, such as maps, indexes or pathway restrictions (Gay, Trumbull, & Mazur, 1991). Some useful techniques in facilitating navigation and avoiding disorientation are guided tours, maps, backtracks, bookmarks, overview diagrams, search engines and *fisheye* views (see Nielsen, 1995).

2.3 Contrast of print and electronic materials

Empirical contrast studies of educative print and electronic materials have shown contradictory results, due to the heterogeneity of research goals, subjects and type of materials used. Some studies show positive results for print materials.[2] There are two studies on comparing still and dynamic images in hypermedia materials. The video information included in both was declarative. Christel (1994) compared two courseware versions. A software engineering course included several records of meetings and other methodological aspects in which students could interact with simulated participants. One version included video at 30 fps and the other version presented the same contents (V) with slides which were replaced every 4 seconds (S). In test sessions, group V

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[1] A review of minimalism research can be found in McCreary & Carroll (1998). Is essential the work of Carroll et al. (1987) and his replication in Lazonder & Van der Meij (1993). For concrete aspects of minimalism, see Nowaczyk & James (1993), Lazonder (1994), Wiedenbeck, Zila & McConell (1995) and Van der Grijspaarde (1995). A multiple perspective on minimalism can be found in Carroll (1998).

[2] See Horton (1994), Brockmann (1990), Nielsen (1995) and Van der Geest (1994) for a review of contrast studies.

recalled 89% of the required information while group S recalled 71%. Pane (1994) assessed a multimedia-learning environment in the biology domain. The study measured the summative effect on students' performance and their satisfaction with the material. Instructional material containing video and simulations (V) was compared with other material containing static graphics (G); the results showed that group V spent more time working through it and scored better than group G. The author speculates that the time difference was probably due to group V projecting the video and simulations more often. These studies suggest that video information can enhance learning in a computer-based environment.

2.4 Hypothesis

Expressed in negative form, the hypothesis are (dependent variables between parenthesis):

Hypothesis 1 (H1): When carrying out tasks, there are no significant differences between users of the hypermedia manual and users of the print manual (voluntary exercises -time and number- near transfer tasks - time and accuracy-, and far transfer tasks-time and accuracy-).
Hypothesis 2 (H2): There are no significant differences in manual access between users of the hypermedia manual and users of the print manual (frequency of access, number of jumps, access time).
Hypothesis 3 (H3): There are no significant differences of opinion about the materials between users of hypermedia manual and users of print manual (ease of use, usefulness, satisfaction, structure and organization, speed of information search and the preference for the other manual).

3 Methodology

3.1 Previous work

We gathered data from users over two academic years through verbal protocols, which showed the most frequent problems users had with the music score editor, the "impasses" or errors they made, methodologies they used to solve problems and whether they needed external help to resolve the impasses. These data allowed us to make a task analysis, task selection and an error-recognizing and correction system to include in the manuals.

Our model of user was one with the following profile: low skills in computer use, a moderate level of motivation in learning with computers, high motivation in learning music programs and a low-moderate level of previous music knowledge. On the basis of this profile and the type of learning intended, we adopted the features of the minimalist model.

3.2 Materials

Before building the two manuals, we translated the music score editor into Spanish in order to: a) make the user's work environment more accessible; and b) eliminate a potential nuisance variable during the experiment.
A task analysis was carried out to determine the tasks to include. In the print manual, the procedural information was presented in text, while in the hypermedia manual it was presented in a digital video format. The hypermedia manual did not display video with other complementary information (textual or graphic) in order to avoid both dividing attention and the appearance of cognitive overload (Sweller, 1994). The manuals consisted mainly of procedural information, except for the first unit, which was devoted to the conceptual, specific terminology used. This unit was a still graphic without text. The structure of both manual contents was logical, sequential and chronological with respect to the task. Contents were split up into twenty units; the unit titles made up the Table of Contents and were used as organizers. The interface was quite straightforward, with a reduced number of control elements that allowed users to run a complete navigation. The hypermedia manual included a help system in order to facilitate operations and minimize the potential cognitive overload Ebersole, 1997).

According to minimalist model, a section called "Posibles Errores" (Possible Errors) for diagnosing and correcting errors was included in eleven units of both manuals, which were most susceptible to syntactic and semantic errors (Carroll, 1990; Lazonder & Van der Meij, 1995). The system consisted of a description of most frequent error and its general or specific corrections. Also, other section termed "Por ti mismo" (On Your Own) was included in order to stimulate user guided exploration and production. With this section, we expected users to do voluntary tasks (see Carroll et al., 1987; Van der Meij, 1993).

Usability tests were carried out with novice users that allowed us to gather data for redesigning the manuals. A pilot test was carried out in order to: a) assess the time necessary to accomplish near and far transfer tasks in experiment; and b) modify the observers' score card. The final version of the print manual was a fifteen-page booklet, whereas the original manual was a 256-page book. The final version of the hypermedia manual was an auto executable (4 Mb.) made using Macromedia's Director with links to 6.4 Mb. of video clips.

3.2 Subjects

To test the fifteen sub hypotheses, we used inter-subject contrast design with volunteer undergraduates on the Music Education Teacher course at the University of La Rioja -Spain. An initial questionnaire about previous experience of use of computers filtered out thirty subjects (11 males and 19 females) with an age range between 17-26 years. This sample was regrouped in sub samples corresponding to nuisance variables (age, course and sex) and assigned randomly to each of the experimental conditions to balance the groups. The subjects were provided with a consent form for participation and received one extra credit.

3.3 Control of variables

The documentation to train with a music score editor program (Encore) was the independent variable; it had two levels: hypermedia manual (HM) and print manual (PM). To balance the experimental conditions, the subjects were grouped in sex, age and course sub samples. They were then randomly assigned to each experimental condition. The program that subjects were to learn was translated into Spanish. The researcher was neither an observer nor an evaluator. The experimental environment was constant: place, hour and computers.
Each of the fifteen observers recorded measurements on two subjects, one of each experimental condition: study time for each instructional unit, time of voluntary exercises and time of transfer tasks in the test stage. Observers also recorded the current unit number and problems expressed by subjects "thinking aloud". Variables related to the users' perceptions were measured with a questionnaire working on a seven-point scale. An external evaluator scored the test files by an evaluation form provided by the experimenter, which indicated scores based on the absence/presence of items required for transfer tasks.

3.4 Experimental environment and procedures

The experiment was carried out in a computer classroom at the University of La Rioja with fifteen Macintosh PowerMac 6230; it took three training sessions of ninety minutes and one test session (one week between each). The print manual was a booklet with fifteen pages of text and graphics.
All the subjects in each experimental condition were told that the research aim was to study how a user learns a music score editor program. They were not informed about the other manual. Based on the data obtained in the pilot test, subjects were assigned thirty minutes to do nine near transfer tasks. These included fifteen different operations to be undertaken out of context. Subjects were assigned fifteen minutes to do one far transfer task. This consisted of replicating a music score and involved the application of knowledge to novel situations and the application of non-explicit information from the manuals. Subjects were not allowed to consult their manual while performing the transfer tasks (test session). When finished with the test session, subjects were provided with a final questionnaire, model A or B depending on the experimental condition, to test the dependent variables on users' perceptions.

4. Results

4.1 Training and learning

Three PM subjects and four HM subjects did not finish all the near transfer tasks. This difference was not significant (means: HM=8,66; PM=8,46).
Analysis of the data related to learning outcomes with the U-Mann-Whitney test showed significant variance (Table 1). A T test for non-related samples was run, which confirmed the significance. According to these results, the HM group scored better in near and far transfer tasks than the PM group.

Table 1
Results of variables related to learning outcomes and their statistical significance (standard deviation between parenthesis. HM=hypermedia manual. PM= print manual)

	number of voluntary exercises	mean time for voluntary exercises (in sec)	mean time for near transfer tasks (in sec)	mean time for far transfer task (in sec.)	mean score of near transfer tasks (max. 21)	mean score of far transfer tasks (max. 20)
HM	18,46 (6,50)	246,59 (92,89)	1477,46 (370,09)	878,86 (57,13)	19,96 (1,74)	19,01 (0,77)
PM	21,06 (7,45)	245,58 (95,26)	1431,60 (390,0)	879,60 (78,96)	16,90 (3,47)	13,83 (2,20)
Significance	U=100; p>0,05	U=90; p>0,05	U=106; p>0,05	U=101; p>0,05	U=43,5; p<0,05 ---------- t= 3,05; df=28; p<0,05	U=4; p<0,001 ---------- =8,60; df=17,43 p<0,001

4.2 Access to documentation

This variable was operationalized as a) number of accesses; b) jumps between non-consecutive units; and c) time of access. The results for number and time of accesses showed statistical significance with the U-Mann-Whitney test (Table 2). A T test for non-related samples confirmed the significance. Group HM consulted the manual less and consumed 33% less time than their counterpart.

Table 2
Results of variables related to access to documentation and their statistical significance (standard deviation between parenthesis)

	Mean number of accesses	Mean number of jumps between units	Total time consulting documentation (in sec.)
HM	49,06 (38,74)	3,53	3213,20 (1465,63)
PM	282,46 (170,81)	2,60	4751,53 (2113,93)
Significance	U=6; p<0,0001 t= -5,16; df=15,44 p<0,001	U=99; p>0,05	U=65; p<0,05 t= -2,32; df=28 p<0,05

4.3 Users' perceptions

The item 13 of the final questionnaire asked subjects to evaluate their preferences for the prominent information modality included in the other manual, the one they don't used (Table 3). The users of print manual would have preferred to use the hypermedia manual to a greater extent than the HM users the print manual.

Table 3 Results of variables related to users' perceptions and their significance (max. 7) (HM=hypermedia manual. PM= print manual)						
	Ease of use	Usefulness	Satisfaction	Organization and structure	speed of searching information	Preferences for the other manual
HM	3,06	6,53	5,86	6,00	2,53	2,00
PM	2,40	6,33	5,86	5,60	2,33	3,93
Significance	U=93; p>0,05	U=98; p>0,05	U=112; p>0,05	U=99; p>0,05	U=100; p>0,05	U=47; p<0,005 t= -3,37; df=20,7; p<0,01

5. Conclusions

The research findings show an effect of the hypermedia manual in learning outcomes; access to manuals and users' perceptions. This effect might have been due to the confluence of several factors that differentiate the manuals. First, the procedural information in the hypermedia manual was exclusively video. The hypermedia manual approached a modeling of the student using a presentation modality that fitted better with the type of learning sought; it produced extra time during training and a better assimilation of task procedures by users. Secondly, the design of the interface -with limited control elements, fast access to information and a low complementary interaction between presentation modalities- minimized the potential cognitive overload and allowed the user to start working rapidly. Designers of educational software materials for novice users should cover users' information needs -focus on user- rather than follow a systemic approach, for example by making a list of what the software is capable of doing. With the incorporation of novice users to learning situations, electronic training materials should be conceived so that the user can quickly build a suitable mental model of the software by explicit wordings from domain knowledge, program features and capabilities, through a real task approach and the presentation of procedural information in the video format.

Further investigations could offer users the freedom to access both types of documentation in order to study the relationships between use frequency and the variables measured. This will help in understanding the reasons why a particular user (expert, intermediate, novice) chooses one or another type of documentation and therefore knowing more on the user's information search strategies. Two variables not studied in this work are the type and number of errors during training. These ones might be important to explain the effect of materials. Though this would require highly trained observers, these two variables and error correction time should be studied to relate them to access to materials and learning outcomes.

This study made a moderate attempt to measure the effectiveness and efficiency of two types of auto instructive learning software materials through a guided exploration by novice users. It left at the margins important matters like learning style influences, degree of learning directivity, training strategies or type of users, which deserve to be investigated.

References

Carroll, J. (1990) *The Nürnberg Funnel: Designing Minimalist Instruction for Practical Computer Skill.* Cambridge, MA: MIT Press.

Carroll, J. (ed) (1998) *Minimalism Beyond the Nürnberg Funnel.* Cambridge, MA: MIT Press.

Carroll, J. (1998) "Reconstructing minimalism". En Carroll, J. (ed) *Minimalism Beyond the Nürnberg Funnel.* Cambridge, MA: MIT Press. 1-18.

Carroll, J., Smith-Kerker, P., Ford, J. & Mazur-Rimetz, S. (1987). "The minimal manual". *Human- Computer Interaction,* 3, 2 . 123-153

Christel, M. (1994) "The role of visual fidelity in computer-based instruction". *Human-Computer Interaction*, 9, 2. 183-223.

Dede, C. (1992). "The future of multimedia: Bridging to virtual worlds". *Educational Technology*, May. 54-60.

Ebersole, S. (1997). "Cognitive Issues in the Design and Deployment of Interactive Hypermedia: Implications for Authoring WWW Sites". *Interpersonal Computing and Technology* , vol. 5, 1-2, April. 19-36 (archived as ebersol IPCTV5N2 in listserv@listserv.georgetown.edu)

Gay, G., Trumbull, D. & Mazur, J. (1991). "Navigational strategies and guidance tools for a hypermedia program". *Journal of Educational Computing Research*, 7(2). 189-202.

Horton, W. (1994) *Designing and writing online documentation*. (2nd. ed.). New York: Wiley & Sons.

Landow, G. (1995) *Hipertexto. La convergencia de la teoría crítica contemporánea y la tecnología*. (Hypertext: the convergence of contemporary critic theory and the technology). Barcelona: Paidós.

Lazonder, A. & Van der Meij, H. (1993). "The minimal manual: is less really more?". *Int. J. Man Machine Studies*, (39). 729-752

Lazonder, A. & Van der Meij, H. (1994) "The effect of error-information in tutorial documentation". *Interacting with Computers*, 6, 1. 23-40.

Lazonder, A. & Van der Meij, H. (1995). "Eror-information in tutorial documentation: supporting users' errors to facilitate initial skill learning". *International Journal of Human-Computer Studies*, 42. 185-206.

Macromedia (1998) *Director 6.5* (computer program).

Mayhew, D. (1992) *Principles and Guidelines in Software User Interface Design*. Englewood Cliffs, NJ: Prentice Hall.

Nielsen, J. (1995) *Multimedia and Hypertext. The Internet and beyond*. Boston: Academic Press.

Pane, J. (1994). *Assessment of the ACSE Science Learning Environment and the Impact of Movies and Simulations*. Pittsburg: School of Computer Science. Carnegie Mellon University. Human-Computer Interaction Institute Technical Report CMU-HCII-94-105.

Redish, J. (1998). "Minimalism in Technical Communication". In Carroll, J. (ed) *Minimalism beyond the Nürnberg funnel*. Massachusetts: MIT Press. 219-246.

Sciarone, A. & Meijer, P. (1993) "How free should students be?" a case from call: computer-assisted language learning". *Computers & Education*, 21 (1-2). 95-101.

Shneiderman, B. (1998) *Designing the User Interface. Strategies for Effective Human-Computer Interaction*. (3rd. ed.). Reading: Addison-Wesley.

Sweller, J. (1994). "Cognitive load theory, learning difficulty and instructional design". *Learning and instruction*, 4. 295-312.

Tejada, J. (1998) "Music technology and multimedia as a music teachers' tool". In Willis, J. et al. (eds.) *Technology and Teacher Education Annual 1998*. Charlottesville, VA: Association for the Advancement of Computing in Education.

Van der Geest, T. (1994) "Hypertext: writing and reading in a non-linear medium". In Steehouder, M., Jansen, C., Van der Poort, P. & Verheijen, R. (eds) *Quality of technical documentation*. Amsterdam: Rodopi. 49-66.

Van der Meij, H. (1992) "A critical assessment of the minimalist approach to documentation". In *Conference Proceedings of the 10th Annual International Conference on Systems Documentation (SIGDOC92)*, (October. Ottawa, Canada). New York, NY: ACM Press. 7-17.

Van der Meij, H. & Carroll, J.(1995) "Principles and Heuristics for Designing Minimalist Instruction". *Technical Communication*, Second quarter. 243-265.

Wiedenbeck, S., Zila, P. L. & McConnell, D.S. (1995) "End-user training: an empirical study comparing on-line practice methods". *Proceedings of ACM Computer-Human Interaction 1995*. New York: ACM Press.

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